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Use of a Radioactive Gas (Kr^{85}) in Diagnosis of Cardiac Shunts.* (23629)

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Accurate localization of left-to-right intra- and extracardiac shunts is not always possible by the measurement of differences in oxygen content of the blood among the right heart chambers. The nitrous-oxide test(1), which depends upon the large arterio-venous difference which normally occurs during the inhalation of an inert gas, has been demonstrated to be more sensitive than the oxygen method. However, analysis of blood samples for nitrous-oxide content requires at least 20 minutes, and precludes the use of the results of the test in the course of the catheterization. The substitution of a radioactive inert gas offered the possibility of a sensitive test, the results of which would be available within a few minutes. The present communication describes the application of krypton^{85} in detection of experimental atrial septal defects.

Materials and method. Atrial septal defects were created in 10 dogs, weighing from 10 to 25 kg. The defects were produced under direct vision during a brief period of inflow occlusion. The interatrial septum was elevated with a traction suture and a portion of the septum, 0.5 to 2.0 cm in diameter, was excised. At intervals of 1 to 16 weeks after operation, cardiac catheterizations were per-

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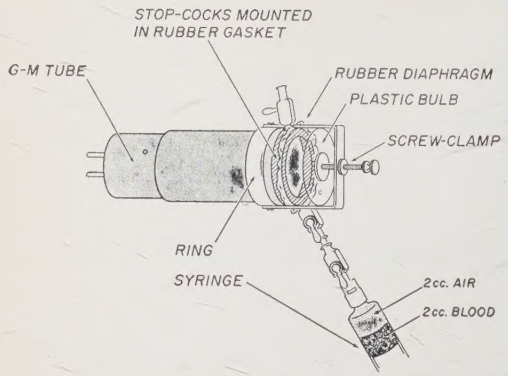

FIG. 1. An air-tight counting chamber over the end of a Geiger tube. A vacuum was first produced in the chamber with suction. The air containing the Kr^{85} was then inj. into the evacuated chamber through the bottom stop-cock. The chamber was easily cleaned by opening both stop-cocks and applying suction for a few seconds.

formed. Under sodium pentothal anesthesia, the trachea was intubated, a cannula placed in a femoral or carotid artery, and a No. 6 or 7 cardiac catheter passed from the femoral or jugular vein into the pulmonary artery. A blood sample for blank determination was drawn from the cardiac catheter immediately before each test. A mixture containing Kr^{85} was prepared by injecting 0.5 to 1.0 mc of the radioactive gas into a breathing bag of 5 liters capacity.† The gas was then diluted to a concentration of 0.1 to 0.25 mc per liter by the addition of oxygen. The mixture was administered to the dog through a closed system consisting of the breathing bag and a carbon dioxide absorption canister. The gas was inhaled for one minute. Blood samples, 2 cc each, were drawn simultaneously from the systemic and pulmonary arteries after 5, 10, 30 and 50 seconds of inhalation. Three more blood samples were drawn at 1, 3 and 5 minutes after the inhalation was discontinued. Repeat tests were done with the same breathing bag by replenishing it with oxygen but without adding more Kr^{85}. The concentration of the gas was thus reduced in each successive test. The test was sometimes performed with the catheter tip in the right ventricle or right atrium, and always repeated in the inferior or superior vena cava. In some instances, 2 cardiac catheters, or double lumen catheters were used to sample 2 areas simultaneously. Five of the dogs were catheterized on 2 separate occasions. The 2 cc blood samples were each drawn into 10 cc oiled, heparinized, Luer-lock syringes. Because Kr^{85} is a beta-ray emitter, much higher counts were obtained by first extracting the Kr^{85} from the blood: Two cc of air were drawn into the syringe which was then closed with a one-way stop-cock. An additional partial vacuum was produced by pulling the plunger of the syringe back another 2 cc. The syringe was then agitated by hand for one minute to accelerate the release of the gas into the air. The 2 cc of air were transferred to an air-tight chamber, previously evacuated by suction, and fixed over the window of a Geiger-Mueller tube (Fig. 1). The samples were counted for one minute and were then washed out of the chamber by opening both stop-cocks and applying suction to one of them. The chamber was usually clear within five seconds.

Results. The Kr^{85} content of systemic arterial blood rose rapidly between the fifth and twentieth second of inhalation and approached its saturation level within 60 seconds (Fig. 2). The appearance of Kr^{85} in vena caval blood was delayed by the circulation time and its concentration then rose much more slowly due to tissue absorption.

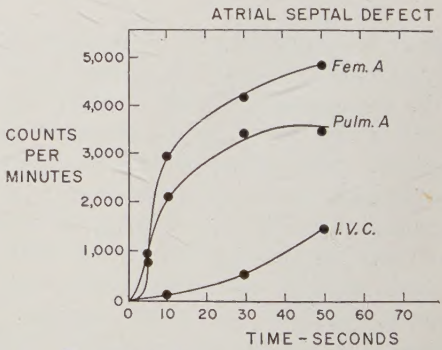

FIG. 2. The saturation curves of arterial, vena caval, and pulmonary arterial blood during one min. of Kr^{85} inhalation in a dog with an interatrial septal defect. The pulmonary arterial curve is the resultant of mixing left atrial and venous blood in the right atrium. Background counts were about 30/min.

† The Kr^{85} was supplied by the AEC and had previously been diluted with atmospheric air to concentration of 1 mc/cc.